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PATENT SPECIFICATION

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COMPLETE SPECIFICATION

A Jointing method of Pipe Shaped Plastics and the Jointing Materials

We, FURUKAWA DENKI KOGYO KABUSHIKI KAISHA of No. 14, 2-Chome, Marunouchi, Chiyoda-Ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to jointing methods of pipe-shaped plastics, such as plastic sheaths of plastic sheathed cables and various plastic pipes, by means of electric heating wire, more particularly to a jointing method of plastic sheathed cables for obtaining a reliable joint by a simple operation.

Owing to the recent increased use of plastics such as polyethylene and polyvinyl chloride for cable sheaths and various pipes, the problem of jointing these plastics becomes more important. In the field of communication cable, plastic sheathed cables, e.g. Alpeth and Stalpeth cables, are superseding conventional lead sheathed cables, and the jointing practice of the plastic sheathed cable is a very important problem to be improved.

For the jointing of the plastic cables, several methods are known, examples on the auxiliary lead sleeve method employing conventional plumbing practices; the mechanical joint box method using rubber packing; adhesive methods using selfadhesive tape or adhesives known as hot-jet; and the epoxide putty method by attaching epoxide putty containing filling agent and hardening agent at the jointing position. Each of these methods has a certain disadvantage in point of simplicity in operation, sufficient and reliable air-tightness, and low cost. Therefore it was desired to obtain a novel jointing method of plastic sheathed cables solving these problems.

A jointing method has been proposed using an electric heating wire. This jointing method comprises the steps of providing turns of electric heating wire at an outer surface of a plastic sheathed cable, which electric heating wire may be plastic sheathed or non-insulated bare wire, providing a plastic sleeve over said heating wire and overlapping each other, and supplying current from a source such as portable batteries and thus jointing between the plastic sheath and the plastic sleeve by welding them together by electric heating.

However, in accordance with the aforementioned method of jointing plastic sheathed cables using electric heating wires, it is necessary to wind said electric heating wires densely with narrow spacings in order to obtain a high efficiency in the operation, and such dense winding of electric heating wires results in an increased change of short circuit between adjacent turns of the electric heating wires. It was found experimentally that if bare wires were used, such adjacent bare wires were apt to make a short circuit directly, and even if plastic insulated wires were used, sometimes short circuiting might occur between adjacent turns when the plastic insulating materials were heated and softened by the heating current passing through the wires.

Such short circuit between the adjacent turns often results in uneven and unsatisfactory welding and even when a satisfactory joint is

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achieved, there is excessive power consumption and considerable decrease in the life of the batteries.

On the other hand, the chances of short circuit could be reduced by winding the heating wire roughly at wide spacing; however, in this case, the efficiency in heating and jointing might be sacrificed. Furthermore, if very thin it takes a considerable time to wind the thin electric heating wire over the cable and it is especially difficult to carry out such winding operations inside of a narrow and dark manhole or on an overhead jointing operation.

It was desired to improve said jointing method of plastic sheathed cables, in which a suitable plastic sleeve is overlapped on plastic sheaths to be jointed and the sleeve and the sheaths are jointed together by heating. Moreover, a method was hoped for of jointing cables by simply abutting plastic sheath and sleeve to be jointed or directly jointing two plastic pipes of the same diameter not using plastic sleeve but simply abutting them together.

Besides, the prevention of moisture permeation at the jointing portion has been substantially effected only by the above-mentioned plastic sleeve even in a case of Staleth communication cable, which is provided with a moisture-proof metal layer, However, a plastic sleeve is not perfectly moisture resistant and have the disadvantage of allowing slight permeation of moisture, and even though the quantity of permeating water is extremely small, a considerable quantity of moisture may pass into the cable through the plastic sleeve in the course of a period of years.

A main object of the invention is to obviate aforementioned difficulties in conventional methods of jointing cables using electric heating wires by providing a novel and economical method of jointing pipe shaped plastics, especially plastic sheathed cables, and comprising simple steps, which may give excellent airtightness and mechanical strength at jointing portions.

One aspect of the invention is to provide an improvement in the electric heating wire to be used for jointing of pipe shaped plastics, so that short circuits may be avoided completely even when electric currents are supplied through densely wound electric heating wires, thereby preventing excessive consumption of the storage battery energy and achieving efficient jointing of the plastic cables.

Another aspect of the invention is to eliminate the need for a turn by turn winding operation using thin electric heating wire, by using either a belt-shaped electric heating wire consisting of a plurality of said heating wires or a jointing plastic sleeve having electric heating wires embedded therein, thereby materially improving the efficiency of the jointing operation.

A further aspect of the invention is to provide a method of jointing pipe shaped plastics by using electric heating wires, which enables joint of two plastic pipes to be performed by abutting them instead of overlapping each other as in conventional methods.

A still further aspect of the invention is to provide a moisture resistant construction of the joint of pipe-shaped plastics jointed by using electric heating wires, so that the permeation of water into the cable, particularly permeation of water into the joint portion of plastic sheathed communication cables, which requires high degree of moisture resistance, can be completely avoided and material improvement can be obtained of the method of jointing plastic sheathed cables.

The invention consists in jointing method for pipe-shaped plastics, comprising the steps of bringing the ends of the pipe shaped plastics to be jointed into adjacency with an electric heating wire, and supplying electric current through said electric heating wire, and thus to heat the adjacent portions of pipe-shaped plastics to be welded together by said heating, wherein said electric heating wire is provided with double insulating layers, which consist of an inner insulating coating, of which the material has a higher heat resistivity than that of the plastic material of the pipe-shaped plastics and an outer insulating layer, which is of substantially the same plastic material as that of the pipe-shaped plastics so as to be united with the pipe-shaped, plastic by heating.

The heating wires may be in the form of a belt-shaped electric heating wire comprising a plurality of electric heating wires, each of which is provided with the inner insulating coating, and which wires are arranged parallel to one another with desired intervals, and embedded in the outer plastic layer.

The ends of the pipe-shaped plastics may be overlapped, abutted or spaced apart.

Alternatively the method may include steps to secure both end portions of said pipe-shaped plastics to be jointed in an abutting position, and in which the heating wire is introduced by applying a plastic sleeve over said abutting position said sleeve comprising insulated electric heating wires previously embedded at the inner periphery thereof, each of said wires having an insulating coating of a higher heat resistivity than that of the plastic materials of the pipe-shaped plastics.

As a further alternative comprising the steps of introducing a plastic sleeve over the ends to be joined and join said pipe-shaped plastics and said plastic sleeve, wherein said sleeve has the insulated electric heating wires previously embedded at the inner periphery thereof, each of said wires having the insulating coating of a higher heat resistivity than that of the plastic materials of the pipe-shaped plastics.

For a better understanding of the invention, reference is made to the accompanying drawing, in which

Fig. 1 is a side view in partial section of a joint between plastic sheathed cables illustrating an embodiment of the jointing method of the invention by using electric heating wire;

Fig. 2 is a transverse sectional view of an electric heating wire having double insulating layers, which is used in the method of the invention;

Fig. 3 is a transverse-sectional view showing an example of a belt-shaped electric heating wire having double insulating layers, according to the method of the invention;

Fig. 4 is a side view of the belt-shaped electric heating wire shown in Fig. 3;

Fig. 5 is a longitudinal sectional view of a joint of pipe-shaped plastics illustrating a second embodiment of the jointing method of the invention using electric heating wires;

Fig. 6 is a similar view to Fig. 5 illustrating a third embodiment of the jointing method of the invention;

Fig. 7 is a longitudinal sectional view of a joint of pipe-shaped plastics illustrating a fourth embodiment of the jointing method of the invention, wherein a plastic tube laminated with a metal layer is interpositioned over the outer surface of the pipe-shaped plastics to be jointed together as shown in Fig. 5;

Fig. 8 is a longitudinal sectional view of a joint of pipe shaped plastics obtained by the method of invention from the step shown in Fig. 6;

Fig. 9 is a longitudinal sectional view of a joint of pipe shaped plastics obtained by combining the jointing methods as illustrated in Figs. 1 to 5;

Figs. 10 and 11 are longitudinal sectional views of first and second embodiments respectively of a plastic sleeve embedded with heating wires;

Fig. 12 is a longitudinal sectional view of a joint of pipe shaped plastics produced by using a sleeve as shown in Fig. 10;

Fig. 13 is a longitudinal sectional view of a joint of plastic sheathed cables obtained by using a plastic sleeve shown in Fig. 11;

Fig. 14 is a longitudinal sectional view of a joint of Stalpeth communication cables illustrating a first embodiment of a method of jointing plastic sheathed communication cables by using a plastic sleeve having a moisture-proof construction;

Figs. 15 and 16 are a longitudinal sectional view and a transverse sectional view respectively of a plastic sleeve having a moisture-proof construction, which is to be used for the joint as shown in Fig. 14;

Figs. 17 and 18 are diagrammatic illustrations showing first and second embodiments respectively of a process for producing plastic sleeves having a moisture-proof construction;

Figs. 19 and 20 are longitudinal sectional views of further embodiments of a plastic sleeve having a moisture-proof construction;

Fig. 21 is a longitudinal sectional view of a spliced portion of a plastic sheathed cables which is produced by providing a moisture-proof means in the outside surface of the spliced portion of cable cores and then applying a plastic sleeve thereon to carry out the jointing process of the invention using electric heating wires;

Figs. 22 and 23 are perspective views illustrating first and second embodiment respectively of a plastic tube laminated with a moisture-proof metal layer, which is to be used in the joint shown in Fig. 21;

Fig. 24 is diagrammatic illustration of the manner in which the plastic tube of Fig. 22 is applied over the spliced portion of cable cores of plastic sheathed cables;

Fig. 25 is a transverse sectional view illustrating the manner in which the plastic tube shown in Fig. 24 is jointed to a plastic sheath of the cable to be jointed;

Fig. 26 is a perspective view of a plastic sheet to be rolled for forming a plastic tube of Fig. 22; and

Fig. 27 is a longitudinal sectional view of a test piece of a joint of Stapeth cables.

Referring to Fig. 1 illustrating a first embodiment of the jointing method of the invention, there is wound electric heating wire 3 on one end portion of a plastic sheath 2 of a plastic sheathed cable 1, said heating wire comprising either electric heating wire having double insulating layers or a belt-shaped heating wire prepared by combining a plurality of said electric heating wires. A plastic sleeve 4 is placed on the outside surface of the electric heating wire in an overlapping manner, and a tightening tape 5 is wound outside of thus overlapping sleeve to hold thus overlapped portion under pressure. Then, the heating wire 3 is supplied with electric current from a power source such as portable storage batteries while applying said compressive pressure to the entire overlapped portion, so that the plastic sheath 2 and the plastic sleeve 4 are united into an integral body by heating, and then the jointing operation is completed.

In the above method of jointing, either electric heating wire having double insulating layers or belt-shaped electric heating wire formed by combining a plurality of said electric heating wires is indispensable for satisfactorily carrying out the jointing process of the invention. Such electric heating wire will now be described in detail hereinafter.

Fig. 2 illustrates an example of an electric heating wire having double insulating layers, wherein a first insulating layer 7 having a higher heat resistivity than that of the plastics to be jointed is applied around a heating conductor 6 to provide an insulated electric heating wire *a*, and the thus prepared insulated electric heating wire *a* is further provided with a second insulating layer 8 consisting of substantially the same plastics are those to be jointed. The conductor 6 is made from one

of such metals as copper, aluminium, iron or Nichrome (Trade Mark), and the first insulating layer is usually applied by baking enamel varnishes such as oleo-resinous enamel or formal enamel, on the conductor and if still higher heat resistivity is required, such enamel contains as polyester or polyamide can be baked thereon. In most cases, various enamelled wires suitable for electromagnets satisfy these requirements. All of these enamel coatings are of thermosetting resins and have excellent heat resistivity as compared with those of plastics.

For instance, the plastics such as polyethylene, polyvinyl chloride and polypropylene are softened at 40 to 150°C and melted at 110 to 190°C; however, the softening temperature of formal enamel coating is higher than 180°C and that of polyamide enamel coating is as high as over 300°C; therefore, formal enamel coating and polyamide enamel coating retain sufficiently high insulating strength as softening temperatures of the plastics.

A coating of aluminium oxide can also be used as said first insulating layer, and for instance an alumite wire, which is a wire suitable for electromagnets, can be used in the jointing method of the invention. The coating of aluminium oxide has an excellent heat resistivity and enough insulating strength even at a temperature as high as 300°C, and in addition, it has an advantage in having a good heat conductivity due to the fact that the insulating layer consists of a metal oxide.

Electric heating wires of the invention having double insulating layers can be obtained by applying the second insulating layer 8 consisting of plastics substantially the same as plastics to be jointed together on the outer surface of the prepared insulated electric heating wires *a*. When such electric heating wire is wound around pipe-shaped plastics, there are provided plastic materials to fill up the gaps between the insulated electric heating wires *a* simultaneously due to the aforementioned construction of the electric heating wires, thereby adjacent electric heating wires are united tightly with molten plastics, resulting in an increased jointing force at the joint and an increased airtightness at the joint.

If enamel coating or alumite coating are used for said first insulating coating 7 as described in the foregoing, they can be made extremely thin, for instance, less than 60 microns for enamel coating and less than 30 microns for aluminium oxide coating. Therefore, a high space factor can be obtained even if such electric heating wires are wound in overlapped layers, and hence the cross sectional areas of the insulating layers of the electric heating wires occupy a negligible part of the entire cross section of the joint and a very high air tightness of the joint can be obtained.

Furthermore, enamel coatings adhere tightly to the plastics to be jointed, and aluminium oxide coatings have porous surfaces and adhere tightly to such plastics as polyethylene. Such tight adhesion of said coating to the plastics to be jointed contributes greatly to airtightness.

Fig. 4 illustrates an example of belt-shaped electric heating wire prepared by combining a plurality of said electric heating wires in an integral body, and Fig . 3 is an enlarged transverse sectional view of the same. In the above belt-shaped electric heating wire, a plurality of the insulated electric heating wires *a* having the insulating layers, 7 are arranged in parallel, and their outer surfaces are covered with a second insulating layer 8 consisting of plastics substantially the same as the plastics to be jointed.

Because of such belt-shaped electric heating wire, the efficiency in winding operation of electric heating wires around pipe-shaped plastics to be jointed is greatly improved as compared with that in conventional method of winding a single heating wire turn by turn. Especially, in case of a jointing operation carried out in a narrow and dark manhole or at an overhead location a great advantage can be obtained.

The jointing method shown in Fig. 1 relates to an overlapping joint of pipe-shaped plastics and another method shown in Fig. 5 relates to a butt-jointing of pipe-shaped plastic of the same diameter and has special advantages that the pipe-shaped plastic of the same diameter can be jointed directly, without any jointing sleeve.

As shown in Fig. 5, jointing edges of pipe-shaped plastics 9, 10, are roughly abutted, and over the inner surface of the jointing edges, a spacer 11 consisting of a metal ring is inserted. Also single or belt formed double insulated electric heating wires 12 of the above mentioned kind are wound on outer surfaces of the pipes, and a plastic layer 13 of substantially the same material as that of the plastic pipes 9, 10 is provided on the electric heating wire. Further, the outside of the plastic layer 13 is kept in pressurized state by winding of pressure tape 14 such as adhesive rubber tape. Then, electric current is supplied to electric heating wires 12 from a suitable electric source as portable batteries and the plastic pipes 9, 10 are united by melting into one body both the jointing edges of the pipes 9, 10 and the plastic layer 13.

To form the plastic layer 13, it is preferred to wind a plastic tape or to extrude the plastics in a molten state. Spacer 11 is provided to prevent the plastics of jointing portion from collapsing inward, and it is preferred to utilize a metal ring. This spacer 11 may be withdrawn after the jointing is performed. Further, the plastic layer 13 can be formed under the electric heating wires 12, as shown in Fig. 6 or layers 13 can be formed at both sides of the heating wires to secure the jointing.

Fig. 7 shows another embodiment of the

jointing method shown in Fig. 5, in which a metal tape laminated with a plastic layer of substantially the same material of the plastic of the pipe-shaped plastics is applied at the outside surface of the pipe shaped plastics to be jointed and the electric heating wires prevent the inner surface of the pipe-shaped plastics from being exposed. In the abutting jointing operation according to the method shown in Figs. 5 and 6, plastics are softened and expanded by heating at the outside of the jointing portion in pressurized state by the electric heating wires, then the electric heating wires may be moved through the softened plastics, and sometimes become exposed at the inner surface of plastic pipes of the jointing portion. In such a case, small bleeding channels connecting inner and outer surfaces of plastic pipes might be produced along the electric heating wires, and therefore there is a risk of spoiling the airtightness. This disadvantage can be mitigated by the arrangement shown in Fig. 7, by providing a metal layer. According to the method, jointing edges 9, 10 of pipe-shaped plastics are abutted together, the spacer 11 is inserted into inner surfaces thereof within the abutting portions also a metal tape 15 laminated by a plastic layer of substantially the same material of the plastics is wound over the outside surface of the joint, and single or belt-shape, double insulated electric wires 12 of the above-mentioned kind are wound on the layers, and the plastic layer 13 of substantially the same material of the pipe shaped plastics 9, 10, is provided on the electric heating wires, further on which pressure wrapping tape 14 is applied to maintain the plastic layer in pressurized state. As electric current is applied to the electric heating wire, the pipe-shaped plastics 9, 10, are welded together to form an integrated body of the jointing portions of the pipes 9, 10, and the plastic layer 13. Thus, by providing the metal tape 15, the electric heating wires 12 are prevented from exposure at inner surfaces of the pipe-shaped plastics at the jointing portion. As the wires are embedded and closely attached to surrounding plastics after jointing operation as shown in Fig. 8, there remains perfectly no bleeding channel along the electric heating wires connecting inner and outer surfaces of the pipe-shaped plastics. As the electric heating wires are provided with higher heat resistive insulation than that of the plastics as mentioned above, there is no risk of short circuit between electric heating wire windings and metal tape. Further, the metal tape 15 is jointed securely to the pipe shaped plastics 9, 10, owing to the lamination of plastic layer of substantially the same material as that of plastics of pipes 9, 10. Although it is preferred to use a metal tape laminated by plastic layer on the both sides, but metal tape laminated by plastic layer on one side only may also be used, and in this case the laminated plastic layer is to be faced to the outer surface of the pipe-shaped plastics during the winding operation.

The metal tape 15 may be laminated with plastic tape by press welding of molten plastics to metal foil, such as aluminium or copper. For example, for jointing operation of polyethylene pipes of the embodiment, the tape was made by aluminium foil of about 50 microns thick, on which molten polyethylene of about 300°C was press-formed by extruding roll, thereby laminating a polyethylene layer of about 30 microns thickness. The laminated layer was welded sufficiently to metal surface, i.e., results of peeling test show peeling strength of 600 g/cm, thus no bleeding channel might be produced between the metal foil and the laminated plastic layer.

Fig. 9 shows another embodiment of the invention, in which jointing of plastic sheathed cables is performed by combination of overlapping jointing method of plastic pipes shown in Fig. 1, and a butt-jointing method as shown in Fig. 5. As shown in Fig. 9, plastic sheaths 18, 19, of plastic sheathed cables 16, 17, to be jointed are overlapped by one end 22 or 23 of auxiliary jointing plastic sleeves 20, 21, with interposition of the above-mentioned double insulated electric heating wires 12, 12^1 or its belt-shaped wire, and the other ends 24 and 25 of the plastic sleeves 20,21 are roughly abutted. Then welding of the ends 22, 23 of the auxiliary sleeves 20, 21 is performed by supplying electric current through the electric heating wires 12, 12^1, while applying outside pressure at the overlapped portions. Thereafter, electric heating wires 12^{11} of double insulation as above are wound over the abutted ends 24, 25 of auxiliary sleeves 20, 21, and over said electric heating wires 12^{11} plastic layer 26 of substantially the same material as that of the auxiliary sleeves 20, 21. Pressurizing means such as rubber adhesive tape 27 is wound on to hold the jointing surfaces in a pressurized state. Jointing of the plastic sheathed cables is performed by supplying electric current to the electric heating wires 12^{11}, thus welding together the abutted portions 24, 25 of auxiliary sleeves 20, 21 and the plastic layer 27.

In the above-mentioned jointing method of pipe-shaped plastics, the process of winding electric heating wires in situ can be eliminated by providing plastic jointing sleeves comprising the double insulated electric heating wires of the above-mentioned type embedded therein. The embodiments of such method are shown in Figs. 10 and 11, showing some embodiments of the jointing sleeve, in which the inner periphery is provided with the electric heating wires 28 embedded therein. Fig. 12 shows an embodiment of jointing using a sleeve shown in Fig. 10. Jointing ends 29, 30 of plastic pipes are roughly abutted, and sleeve 31 in which electrical heating wires 28 are embedded is overlapped over the abutted edges,

then over the sleeve 31 pressing tape 32 is wound. By supplying electric current to the electric heating wire 28 through leads 33, 34, jointing is performed by heating and welding together the ends 29 and 30 of the pipe-shaped plastics and the sleeve 31. Also in this procedure, spacer 11 may be interpositioned to prevent the plastics of the jointing portion from collapsing inward.

A sleeve shown in Fig. 11, in which electric heating wires are embedded at both ends of the inner periphery, may be used to joint plastic sheathed cables 36, 37, having spliced portion 35 of the cable cores as shown in Fig. 13.

Further, sleeves formed by embedding the electric heating wires are not limited to the constructions mentioned above, and may also be formed to be used in jointing a branch connection of pipe-shaped plastics and a terminal sealing cap of plastic cables.

In jointing moisture-proof cables such as Stalpeth cable, it is very important to keep the jointing portions moisture-proof. In the jointing procedure above mentioned, that plastic sleeve is applied to the jointing portion, in which moisture-proof metal layer is cut apart at the splicing portion of cable cores, so that moisture-proofness will only rely upon the plastic sleeve at the jointing portion. However, as moisture slightly permeates plastics, this practice has a disadvantage that insulating resistance of cable cores may deteriorate due to moisture having permeated the plastic sleeve and passed into the cable cores through the spliced portions thereof in a period of years. As water vapours generally constitute a great risk in manholes, through which the cables are laid, the volume of moisture having permeated in the plastic sleeve of the jointing portion can increased considerably in many years. Calculations were performed in case of Stalpeth cables of about 67 mm outside diameter, on which polyethylene sleeve of 3 mm thickness, 100 mm inside diameter, and 600 mm length was covered at jointing portion, and exposed to an atmosphere of 20°C temperature and 100% humidity. The result was, with moisture permeating coefficient of polyethylene taken as 0.5 to 0.5×10^{-9} (g.cm./cm.^{2}hr.mmHg), that 0.4 — 0.5 g of water vapour would permeate in a year, and that considerable amount would permeate in many years. According to the present invention, such disadvantage can be mitigated.

Fig. 14 shows one embodiment of such moisture-proof jointing in which, Stalpeth communication cables 38, 39, to be jointed are provided with moisture-proof metal layers 42, 43, at the inner surface of plastic sheaths 40, 41, and the jointing portion of the cable is covered with plastic sleeve 44 providing moisture-proof construction, edges 45, 46 are overlapped with the plastic sheaths 40, 41, and between such edges and sheaths are wound the above-mentioned double insulated electric heating wires 12, 12^1. The jointing operation is performed by supplying electric current through the electric heating wires, and the plastic sheaths 40, 41 and the sleeve 44 are joined by melting them together.

The sleeve 44, applied to this embodiment is shown in Fig. 15, and is formed of tubular plastics layers 45 of substantially the same material as that of the plastic sheaths 40, 41 to be jointed, between which a metal layer 46 is buried. Manufacture of a sleeve S 44, may be as follows: i.e., extrusion forming of molten plastic applied to the outer and inner surfaces of a thin metal sleeve, or helically winding as shown in Fig. 17 or longitudinal winding as shown in Fig. 18 of plastics laminated metal tape 47 to the outer surface of plastic tube to form a tube and welding the plastic layer 49 laminated to the metal layer to the plastic tubes 48, 50.

The construction of moisture-proof sleeves above-mentioned are plastic tubes having a metal layer embedded therein, but in another embodiment as shown in Figs. 19 and 20, sleeves may be used that are made by plastic tubes applied to a metal layer at outer or inner surfaces.

A jointing portion using the above-mentioned moisture-proof sleeve shows good moisture-proofness. To illustrate this permeating test results of polyethylene sleeves with and without moisture-proof provision were as follows. The test samples were made of aluminium strip 0.05 mm thick, on which polyethylene 0.1 mm thick was coated and made to a tape of 60 mm width. The tape was wound on a plastic tube about 2 mm thick by 1/3 overlapping, on which polyethylene 2 MM thick was formed by extrusion, to form a sleeve of 60 mm outside diameter. The sleeve above mentioned was compared to a polyethylene sleeve of about 4 mm thickness and 60 mm outside diameter, the vapour permeating amount in 20°C water. The test result is as shown in Table 1.

TABLE 1

Polyethylene sleeve	permeated amount
with moisture-proof	1.0×10^{-6} g/m.min.
without moisture-proof	4.5×10^{-6} g/m.min.

As clearly shown in the test result above mentioned, polyethylene sleeve with moisture-proof provision shows low permeation at about 1/5 as compared to polyethylene sleeve without any moisture-proofness.

Fig. 21 shows another embodiment of moistureproof jointing of plastic sheathed cables, providing a plastic tube 52 of moisture-proof construction, directly covering the cable core jointing portion 51. In this case, plastic tubes laminated to a metal layer 53, as shown in Figs. 22 and 23, are employed, and the embodiment shown in Fig. 21 provides a sleeve shown in Fig. 22, made by a plastic tube 52 having a metal layer 53 laminated onto the outer surface.

To form the jointing portion shown in Fig. 21, spliced portion 51 of cable cores is covered by plastic tube 52 laminated to a metal layer as shown in Fig. 24. The outer surface of plastic tube 52 is laminated to metal layer 53, and the tube is folded as shown in Fig. 25, on both ends of plastic sheaths 54, 55, on which an electric heating wire or heating iron is applied to heat and weld the plastic layer 52 to the cable sheath 56, and the plastic layers 52 to each other, and to effect jointing of plastic tube to the edges of cable sheaths. After applying the metal laminated plastic tube to the cable cores jointing portion of the cable, plastic sleeve 57 is applied to cover the jointing portion, both ends of the sleeve are welded following the above mentioned procedure providing electric heating wires, resulting the jointing portion shown in Fig. 21.

To make metal laminated plastic tube, a preferrred example is as follows: A plastic sheet comprising a polyethylene layer 52 welded to metal foil 53 as shown in Fig. 26, is formed into a tube with the polyethylene layer inside, and by welding the polyethylene layer by heating the overlapping portion. Plastic sheet laminated by metal foil as shown in Fig. 26, may be formed by an extrusion roll, by applying molten plastics to metal foil such as aluminium or copper, and the peeling strength between the layers is sufficient. Tubes as shown in Fig. 23 are formed from metal foil having molten polyethylene layers on both of its sides, while tubes shown in Fig. 22 are formed from metal foil having the molten polyethylene on one of its sides. By this embodiment, to aluminium foil 0.05 mm thick, 0.05 mm of polyethylene was applied, and the peeling strength was greater than the tensile strength of polyethylene film.

To apply plastic tube to electric cores jointing portion, the operation is performed simply and conveniently, after the said portion is covered by a sheet as shown in Fig. 26, forming is performed tubularly as shown in Fig. 22; however, the operation can also be performed by another procedure, in which, a metal laminated plastic tube formed previously, is inserted in the cable, and is moved to the jointing portion after cable cores are jointed.

In case of gas sealing in the cable, the plastic tube above-mentioned is made to have about the same volume of plastic sleeve to cover the tube, then the plastic tube will not burst from expanding by gas pressure pressed by outside plastic sleeve. Also, the outside plastic sleeve will resist mechanical force to jointing portion, so that the plastic tube can be very thin, and 0.1 mm thick or this embodiment is sufficient.

Although some embodiments of this invention are described above, some test results of the jointing portion of plastic sheathed cable according to the invention are as follows:

A jointing portion shown in Fig. 27 was provided to joint 0.65 mm x 1,000 pair Stalpeth cable, the test results are shown in Table 2.

TABLE 2

Terms of test	Test procedure	Test result
Tension test	* Tensile load applied to AB shown in Fig. 27 * Load is increased by 50 kg * Keep 100 min. by every load	* Breaking load 850 kg * Breaking point: Auxiliary sleeve
Heat cycle test	* Sealed gas pressure 1 kg/cm^2 * Temperature −40° C. = 60° C.	* No evidence after 10 cycles
Vibration test	* Sealed gas pressure 1 kg/cm^2 * Load 100 kg * Vibration 800 cycles * Amplitude ± 2 mm	* No evidence after 700 hr.
Pressure test	* Sealed gas pressure 2 kg/cm^2	* No evidence after 50 hr.

A surprisingly excellent result was obtained according to the invention as shown in such result of the severe tests.

As mentioned above, this invention relates to a series of methods of jointing plastic pipes (especially plastic sheathed cables) with electric heating wires, and has distinct advantages of simple operation, reliable jointing, and low cost of the practice.

WHAT WE CLAIM IS:—

1. A jointing method for pipe-shaped plastics, comprising the steps of bringing the ends of the pipe shaped plastics to be jointed into adjacency with an electric heating wire, and supplying electric current through said electric heating wire to heat the adjacent portions of pipe-shaped plastics to be welded together by said heating, wherein said electric heating wire is provided with double insulating layers, which consist of an inner insulating coating, of which the material has a higher heat resistivity than that of the plastic material of the pipe-shaped plastics and an outer insulating layer, which is of substantially the same plastic material as that of the pipe-shaped plastics so as to be united with the pipe shaped plastics by heating.

2. A jointing method as claimed in claim 1, in which the heating wires are in the form of a belt-shaped electric heating wire comprising a plurality of electric heating wires, each of which is provided with the inner insulating coating, and which wires are arranged parallel to one another with desired intervals, and embedded in the outer plastic layer.

3. A jointing method as claimed in claim 1 or 2, wherein the pipe shaped plastics to be jointed consists of plastic sleeves and/or plastic sheaths of plastic sheathed cables.

4. A jointing method as claimed in claim 1 or 2, wherein the pipe shaped plastics consists of plastic pipes.

5. A jointing method as claimed in any of claims 1 to 4, in which the ends of the pipe shaped plastics are overlapped with inter position of the heating wire.

6. A jointing method as claimed in claim 1, 2 3 or 4 in which the end portions of pipe-shaped plastics to be jointed are secured in an abutting position, with the electric heating wire wound over both of said end portions and pressure is applied from outside of the plastic layer during heating.

7. A jointing method as claimed in claim 6, in which a plastic layer is formed over both end portions to be jointed with substantially the same plastic material as that of the pipe-shaped plastics, with the electric heating wire being wound over the plastic layer.

8. A jointing method as claimed in claim

6 comprising the steps of winding a metal tape covered with a laminated plastic layer of substantially the same material as that of the pipe-shaped plastics, over both end portions to be jointed, the electric heating wire being wound over the metal tape to cover both end portions to be jointed, forming a plastic layer over the electric heating wire with substantially the same plastic material as that of the pipe-shaped plastics.

9. A jointing method as claimed in any of claims 1 to 8, wherein the insulating coating of the electric heating wires, having a higher heat resistivity than that of the plastic material of the pipe-shaped plastics, consists of an enamel coating.

10. A jointing method as claimed in any of claims 1 to 8, wherein the insulating coating of the electric heating wire, having a higher heat resistivity than that of the plastic material of the pipe-shaped plastics, consists of a coating of aluminium oxide.

11. A jointing method as claimed in claim 1, comprising steps to secure both end portions of said pipe-shaped plastics to be jointed in an abutting position, and in which the heating wire is introduced by applying a plastic sleeve over said abutting position said sleeve comprising insulated electric heating wires previously embedded at the inner periphery thereof, each of said wires having the insulating coating of a higher heat resistivity than that of the plastic materials of the pipe-shaped plastics.

12. A jointing method as claimed in claim 1 of pipe-shaped plastics, comprising the steps of introducing a plastic sleeve over the ends to be joined and joining said pipe-shaped plastics and said plastic sleeve, wherein said sleeve has the insulated electric heating wires previously embedded at the inner periphery three-of, each of said wires having the insulating coating of a higher heat resistivity than that of the plastic materials of the pipe-shaped plastics.

13. A jointing method as claimed in claim 12, in which the plastic sleeve comprises a metal strip with a plastic layer laminated on at least one side thereof, which is formed into a tube by winding it either helically or lengthwise, and a plastic tube applied over said laminated plastic layer of said metal tube, said plastic layer and plastic tube being melt-bonded together.

14. A jointing method as claimed in claim 13, wherein said metal strip is an aluminium strip.

15. A method of joining pipe-shaped plastics substantially as hereinbefore described with reference to the accompanying drawings.

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Fig. 1.

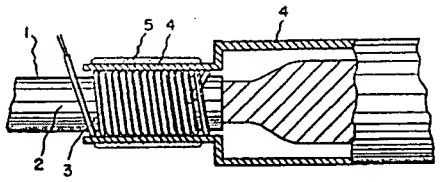


Fig. 2.

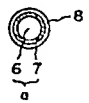
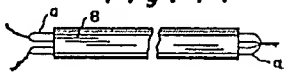


Fig. 3.

Fig. 4.



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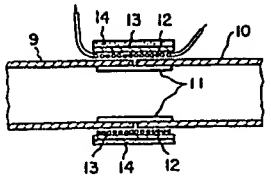

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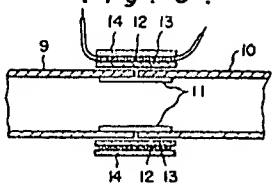

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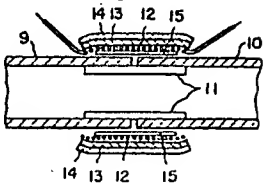

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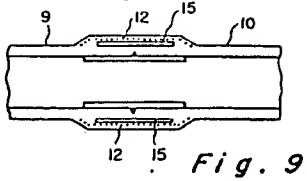

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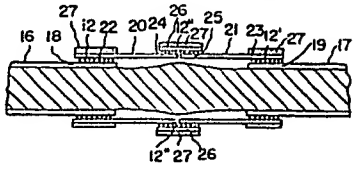

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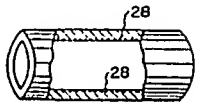
Fig. 10.



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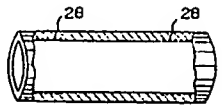

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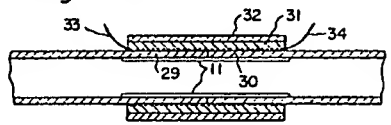

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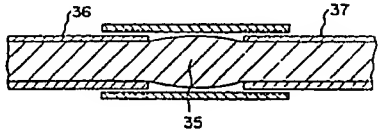

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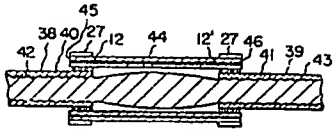

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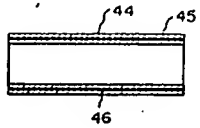
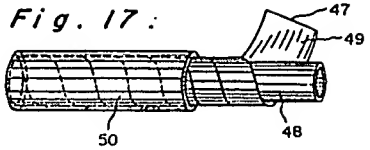


Fig. 16.

Fig. 17.



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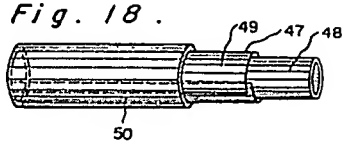

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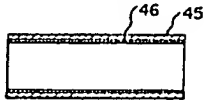

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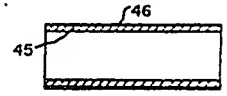

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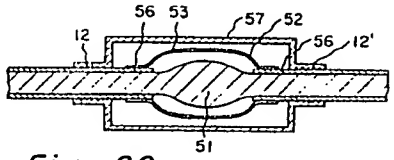
Fig. 21.



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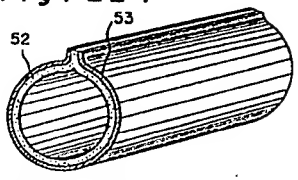

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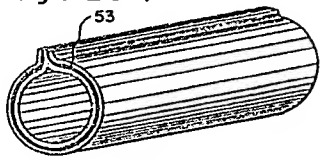

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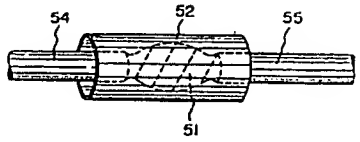

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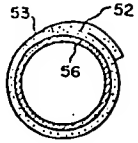

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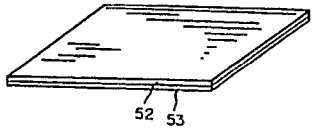

Fig. 27.